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Quantitative Assessment of Vitamins A and E in some selected edible oils in Igbesa, Ogun State, Nigeria

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ABSTRACT

The Quantitative Assessment of Vitamins A and E in some selected edible oils in Igbesa, Ogun State, Nigeria has been successfully conducted with the intent to identify the extent to which both local and foreign manufacturers respond to the demand that they fortify vegetable oils with Vitamins A and E. These vitamins are usually lost as a result of processing and refining. The locally produced vegetable oils A, B and C gave low values of Vitamin A; 1.15 µg/100 mg, 1.45 µg/100 mg and 1.90 µg/100 mg while the foreign vegetable oils gave higher values; 3.40 µg/100 mg, 3.42 µg/100 mg and 3.50 µg/100 mg. In the same vein, the locally produced vegetable oils also gave lower values of Vitamin E; 0.0215 µg/100 mg, 0.0230 µg/100 mg and 0.0380 µg/100 mg whereas the foreign vegetable oil samples gave higher values as 0.0389 µg/100 mg, 0.0396 µg/100 mg and 0.0455 µg/100 mg. These results evidently shows that most local vegetable oil producers do not want to border about underwriting the cost of fortifying their vegetable oil products and nobody seem to be worried over that.

Keywords: Tocopherol, Beta-Carotene, Lipids, Spectrophotometry, Calibration

I. INTRODUCTION

Vegetable oils are classified as lipids derived from plant material and are liquids at room temperature unlike fats derived from animal materials which are solids at room temperature. Fats are spread all over the animal body just like many parts of the plant body but in practice, commercial source of plant oil of animal fat derives from the plant seed and animal tissue.

Plant oils contain more unsaturated fatty acids while animal fats contain more saturated fatty acids. Good examples of unsaturated fatty acids are lauric, oleic, linoleic, and linolenic acids (Ophardt, 2003). These are known as essential fatty acids since they are required in the body but the human body cannot synthesize them. Lipids however can be generally defined as the class of cellular biomolecules that are only sparingly soluble in water and other polar solvents but are highly soluble in non-polar organic solvents (Anosike, and Chibogwu, 2007).

The discovery of vitamin A dated as far as 1906 when it was believed that there were other factors other than carbohydrates, proteins and fats that were necessary to keep cattle healthy. Researchers like Elmer McCollum working at the University of Wisconsin-Madison, Thomas Burr Osborne at Yale University and Lafayette Mendel independently isolated one of these substances in 1917. This “fat soluble factor” was later named *vitamin A*. Steebock from University of Wisconsin proposed a relationship between vitamin A and the yellow plant pigment (beta-carotene) in 1919 and it was firstly synthesized in 1947 by the two Dutch chemists; David Adrian van Dorp and Josef Ferdinand Arens (Wolf, 2001). Vitamin E occurs in vegetable oils, wheat, corn rice,

eggs, liver and butter. It functions particularly as an anti-oxidant, inhibiting the oxidation of free unsaturated fatty acids. This vitamin was discovered in 1922 during some experiments with rats but the first use as a therapeutic agent was in 1938 by Widenbauer, who used wheat germ oil supplement on 17 premature new born infants, suffering from growth failure. 11 out of the original 17 patients recovered and were able to resume normal growth rates (Bell, 1987).

Vitamin A is essential for numerous intrinsic processes in human body. The most well-known and understood process is that of chemistry of vision. The 11 – cis retinal form of vitamin A is essential for the neural transmission of light into vision (Ross, 1999). A developing fetus is highly dependent on retinoic acid and it is essential to the growth of the eyes, lungs, ears and heart (Groff, 1995). The retinoids are not the only active form of vitamin A, but also a current area of scientific interest especially in its role as an antioxidant or pro-oxidant. However in recent years the carotenoids like β-carotene have attracted more attention because of the harmful role they play as pro-oxidants (Volpe, 2000). Vitamin A deficiency is estimated to affect approximately a third of children under the age of five around the world (WHO; 1995 - 2005). It is estimated to claim the lives of 670,000 children under five years annually (Black, Allen, Bhutta, Caulfield, De Onis, Ezzati, Matters and Rivera, 2008). Low intake of Vitamin A and Zinc has been observed to be common in malnourished populations leading to increase in the severity of Vitamin A deficiency and attendant physiological signs and symptoms of deficiency (Comb, 2008). In Burkina Faso, a study conducted among young children revealed major reduction of malaria morbidity with combined vitamin A and Zinc supplementation (Zeba, 2008). It has been recommended that adequate supply of vitamin A is especially important for pregnant and breast feeding women to assist in normal development of the fetus. This is because deficiencies of these vitamins cannot be compensated by postnatal supplementation (Strobel Tinz and Biesalski 2007).
Inhibition of Vitamin A metabolism as a result of alcohol consumption during pregnancy can be disclosed in the mechanism for fetal alcohol syndrome (Crab, 2001). Significantly high doses of vitamin A as well as other pharmaceutical retinoids like 13 – cis retinoic acid, are likely to produce the syndrome of pseudo tumor cerebri (Brazis, 2004). This syndrome includes headache, blurring of vision and confusion associated with intra-cerebral pressure. Symptoms begin to resolve when intake of the offending substance is restored (Penniston and Tanumihardj, 2006). A study has shown a correlation between too high intakes of vitamin A and low bone mineral density (Forsmo, 2008). Vitamin E does not decrease mortality even at large does (Liandro, Marieta and Abner, 2011) and may slightly increase it according to a Cochrane Review (Bjelakovic, Nikolova, Gluud, Simonetti and Gluud (2008). It does not improve blood sugar control in an unselected group of people with diabetes mellitus (Abner, 2011) or decrease the risk of stroke (Bin, 2011).

It has been advocated that in a process of assessing the nutrient content of diets, recipes or commercial food products, a nutrient database should provide a complete nutrient profile for each food in the database. Sally, Schakel, Buzzaard and Gebhardt, (1996) suggested that to verify and validate the appropriate data selection, calculation methods and data entry which will eventually be utilized, quality control procedures and nutrient validation programmes should be properly implemented.

Micro calorimetric studies have been performed to estimate the content of vitamin (tocopherols) in natural plant oils. The kinetic method of estimating vitamin was the approach and this was based on the inhibitory ability of tocopherols in a liquid-phase free radical oxidation reaction (Sizova and Andreeva, 2007). A model reaction consisting of the initiation of isopropyl benzene oxidation showed that fatty oils

inhibit the free radical reaction with an induction period proportional to the content of tocopherols in the oils. Experimental curves were used to calculate oxidation inhibition rate constants. Current semi-quantitative and quantitative analysis methods for assessment of retinyl palmitate in oil are technically quite demanding and can be expensive; e. g. the qualitative method based on the formation of anhydro-retinol (Bayfield, 1971), the quantitative spectrophotometric (Kamangar and Fawzi, 1978), or high-performance liquid chromatography (HPLC) methods (Bui, 1994). Qualitative methods do not measure the adequacy of fortification; rather they provide information on the presence or absence of a fortificant, which is often insufficient (Pandav, Arora, Krishnan, Sankar, Pandav and Karmarkar, 2000).

A spectrophotometric method based on multiple linear regressions has been proposed for the simultaneous determination of vitamin A, D and E in multivitamin pharmaceutical preparations (Blanco, Coello, Iturriaga, Maspoch, Gomez-Cotin, Alaoui-Ismaili and Rovira, 1995). Most vitamins are directly extracted from the preparations into n-hexane. Micro encapsulated vitamin A preparations require pre-treatment of de-capsulation before the vitamin is extracted. The wavelength range to be used for each preparation and the optimum spectral mode (absorbance or first derivation) has been chosen in order to assure correct quantitation. This will also avoid interferences coming from other absorbing species which may be extracted by n-hexane. The results obtained were validated by simultaneous HPLC analyses for accuracy and precision.

Fat soluble vitamins; A, D, E, K1 and vitamin esters, A acetate and E acetate have been resolved and quantitated in paprika and paprika oleoresin. The analysis was carried out by reverse-phase gradient elution high performance liquid chromatography with spectrophotometric detection. Paprika samples were extracted with ethyl acetate and the extract directly injected at room temperature without prior hydrolysis or isolation steps (Vinas, Campillo, Garcia and Cordoba, 2003). Thus the method can be useful for the quality control analysis or the routine determination of fat soluble vitamins in commercial samples of paprika or paprika oleoresin.

A more rapid sensitive method has been developed for the simultaneous determination of retinol acetate, δ-, γ-, α-tocopherol and α-tocopherol acetate. Two experimental procedures are compared for simultaneous direct solvent extraction of these vitamins without previous saponification (Mendoza, Olguin, Lafferte, Thomas, Ebitsch, Gundelfinger, Kukuljan and Sierralta, 2003). In method I the fat milk sample was extracted with ethanol-hexane and injected directly into the column and in the method II, the powdered milk sample was extracted with ethanol-hexane and also injected directly into the column. The precision results showed that the relative standard deviations of repeatability and reproducibility were between 0.74 and 5.7%.

II. EXPERIMENTAL

The six edible vegetable oil samples used for this analysis were bought from local markets in Igbesa, Ogun State and were all were assayed for vitamin A and E. The first three samples A, B, and C were locally produced while the last three samples D, E and F were foreign. The objective was to determine the extent of fortification of these vegetable oils by their producers most of who do not border about what could have been lost in the process of refining of vegetable oils. Carr – Price Method using the Carr – Price reagent was adopted. This method uses Antimony trichloride ($SbCl_3$) in chloroform and the principle is that double bonds of the retinol molecule react in the formation of an anhydroretinylic and a retinylic cation, yielding a brilliant blue color. The absorption of the blue color is dependent on the concentration of the solution and is measured at 610 nm in the spectrophotometric measuring unit. 2 g of each oil sample were accurately weighed into 100 ml beakers and 1 g of sodium anhydrous sulphate added to precipitate moisture

from each sample. The cleaned sample was transferred into different test tubes. Same was done for the standard tocopherol and β- carotenoid standards. 100 ml of petroleum spirit was added after the clean-up and the blue colour read immediately at 610 nm. For the vitamin E, the samples were again separated using column chromatography on silicic acid due to the sensitivity of tocopherol on alkali solutions. 2 mls of petroleum ether and 2 mls of ethanol were added for homogenization. The mixture was transferred into a test tube and 0.2 ml of dipyridyl and 0.2 ml of ferric chloride solution added and mixed thoroughly. The solution was kept in a dark for 5 minutes to develop an intense red colour. The colour which intensifies after 30 minutes was measured at 520 nm using cuvettes PMMA (280 – 800).

III. RESULTS

The quantitative assessment of Vitamins A and E in some selected edible oils in Igbesa, Ogun State, Nigeria has been carried out successfully using spectrophotometric method and the results obtain are shown below:

Table 1. Serial Dilution for the calibration curve for Vitamin A and E

Conc. µg/100ml	Absorbance (610 nm)	Conc. µg/100ml	Absorbance (520 nm)
0.5	0.061	0.01	0.150
1.0	0.120	0.02	0.310
1.5	0.179	0.03	0.475
2.0	0.240	0.04	0.631
2.5	0.300	0.05	0.790
3.0	0.360		
3.5	0.420		
4.0	0.480		

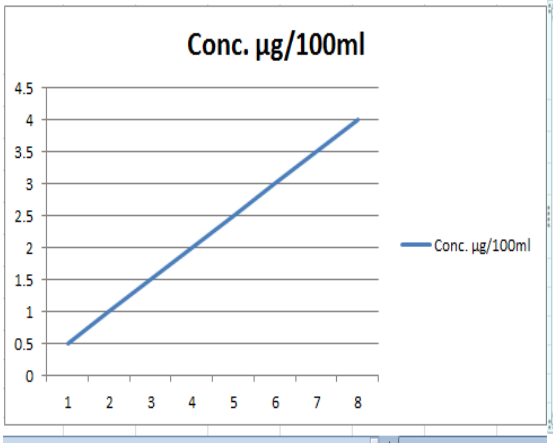

Figure 1. Calibration curve for Vitamin A

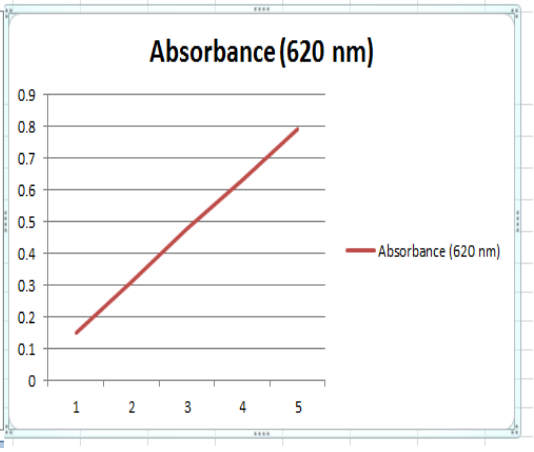

Figure 2. Calibration curve for Vitamin E

Table 2. Results of analysis of samples for Vitamin A and E

Sample	Absorbance	Vit. A. Conc. µg/100mg	Absorbance	Vit. E. Conc. µg/100mg
A	0.155	1.45	0.597	0.0380
B	0.144	1.15	0.361	0.0230
C	0.225	1.90	0.336	0.0215
D	0.414	3.40	0.721	0.0455
E	0.443	3.50	0.609	0.0389
F	0.423	3.42	0.650	0.0396

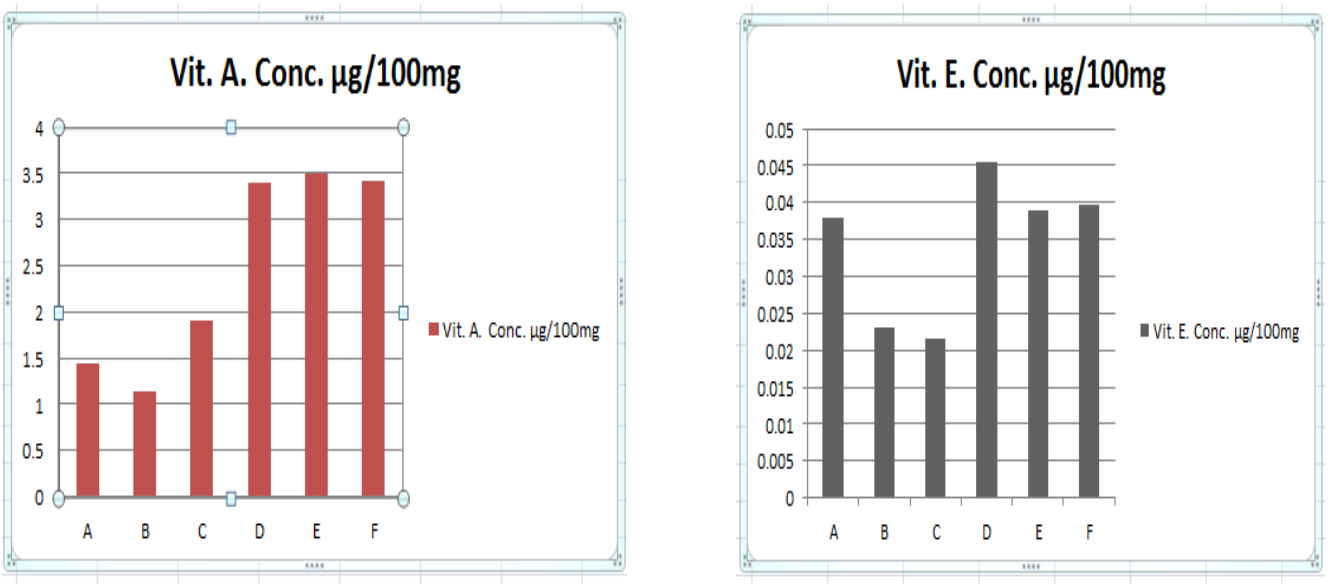

Figure 2. Bar Charts showing (a) the variations of Vitamin A and (b) E in the various samples

IV. DEDUCTION

Refining of vegetable oils require that they pass through acid degumming, bleaching using activated earth and deodorizing in a distillation chamber. The high temperature treatment of vegetable oils during refinery operations leaves very little percentage of them in the final product. This then mean that these products need be replenished of the lost Vitamins and WHO, FDA and the local agency NAFDAC made mandatory that producers effect this fortification before bringing their products the consumers. However, these results obtained shows clearly that the locally produced vegetable oils A, B and C gave low values of Vitamin A; 1.15 µg/100 mg, 1.45 µg/100mg and 1.90 µg/100 mg while the foreign vegetable oils gave higher values; 3.40 µg/100mg, 3.42 µg/100mg and 3.50 µg/100 mg. These results show that there was no extra fortification of the locally produced vegetable oils. The little concentration of these Vitamins was the remnants after refining. In the same vein, the locally produced vegetable oils also gave lower values of Vitamin E; 0.0215 µg/100 mg, 0.0230 µg/100 mg and 0.0380 µg/100 mg whereas the foreign vegetable oil samples gave higher values as 0.0389 µg/100 mg, 0.0396 µg/100 mg and 0.0455 µg/100 mg. It is also pertinent to note that vegetable oils have different rate at which they tolerate heat treatment. This factor is dependent on their flash points as well as the molecular weight of the predominant fatty acid.

V. CONCLUSION

The consumption of vegetable oils having low vitamin content has been discouraged all over the world. Except for palm oil which contains palmitic acid which is sometimes consumed in its raw form, other vegetable oils undergo one form of treatment or the other in an effort to reduce the triglycerides

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